UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF ENTOMOLOGY

FOREST INSECT INVESTIGATIONS

# NOTES ON THE LIFE HISTORY OF THE LODGEPOLE NEEDLEMINER

by

K. A. Salman and G. S. Hensill
Berkeley, California
November 26, 1935

U. S. GOVERNMENT PRINTING OFFICE: 1928 J 76133

Forest Insect Laboratory
Berkeley, California
December 14, 1935

# NOTES ON THE LIFE HISTORY

# of the

# LODGEPOLE NEEDLEMINER

Approved by:

J. M. MILLER

Senior Entomologist, in Charge

Submitted by:

W. B. Salman

Associate Entomologist

C. J. Hensill

Scientific Aide

# TABLE OF CONTENTS

# NOTES ON THE LIFE HISTORY OF THE LODGEPOLE NEEDLEMINER

by

K. A. Salman and G. S. Mensill

Mr. J. E. Patterson worked on the life history of Recurvaria milleri Busck from 1917 to 1919 and published his results in 1921*. The experimental control project of 1933 gave an opportunity to study some phases of the life history of this species. In 1935 study of other phases of the species was made necessary by the requirements of the control experiments. Some minor disagreements with Patterson's results have been found. Quantitative data on or substantiation of previous information concerning other phases of the life history and habits of this species have been secured. It is considered advisable to place this information on record.

## MIGRATION OF MATURE LARVAE

Dr. Mensill examined infested needles in the vicinity of Snow Creek Cabin at about 7600 feet altitude on April 18 and again on May 14, 1935. On his first trip a few recently formed mines were found. Migration and attack of new needles was noticeably well under way by the time the second trip was made. These observations advance the date on which this migration begins by about two weeks.

It is probable that activity resulting in migration and formation of new mines is a response to temperature conditions and will very from year to year. This point is advanced on the fact that specimens removed to a warmer climate on April 3 began migrating soon after, pupated May 9 and the first adult appeared May 31. These dates of pupation and emergence are much earlier than any records that have been secured in the cooler normal habitat.

The nearly full grown larvae, when attacking another needle, attach two needles together by means of a web and attack the inner surface of the new needle under the protection of this covering. Often, although not always, they attack the uninfested needle remaining in the fascicle on which they have been working.

## OFF-SEASON BROODS

Approximately 150,000 needles were examined for infestation during the season of 1935. Four larvae of the 1933 or possibly of a 1934 brood, were found that apparently would not pupate and emerge in 1935. These figures indicate the off-season brood strength is but 1/100% of that of the normal 1935 brood and that it enters into the infestation of but 3/1000% of the needles. Substantiation is secured for previous observations on the marked synchronization of practically all individuals of the species in their life history activities as well as the relative unimportance of the off-season brood.

* Patterson, J. E. Life History of Recurvaria milleri, the Lodgepole Needleminer in the Yosemite NP. Jour.Ag.Res. 21:127-142, 1921.

## HOST TREES

Patterson found lodgepole pine to be the only host of the species in those portions of the Yosemite National Park in which he did his work. Mr. Miller secured specimens of a moth from Jeffrey pine in the Sequoia National Park that were first determined as Recurvaria milleri. Later (1919) they were determined as individuals of another species, although no specific designation was given; see Hopkins No. 13986a.

In and near Porcupine Flat, as well as in other parts of Yosemite National Park, needleminers were found in other host tree species. However, rearings were made in sufficient numbers only from jeffrey pine material collected near Merced Lake. Superficial aspects of the adults indicated them to be Recurvaria milleri. However, final identification will have to await the opinion of a systematist.

## EMERGENCE OF ADULTS

At Porcupine Flat (7900 feet altitude) pupation of the 1933 brood was under way early in July, 1935. The first adult was seen in the field on July 11. Emergence from needles collected in order to secure records of that phenomenon started on July 20. It is probable, because of the relatively small sample (200 needles) used in the record up to and including July 23, that some emergence occurred before that date. Emergence was practically completed by the first week in August (See figure 1). These records on emergence agree fairly well with Mr. Patterson's observations.

## FLIGHT OF MOTHS

The flight period and more particularly the density of population in flight was determined by observation and sampling. Samples were secured by 25 sweeps of an insect net in the lower branches of trees in restricted areas. These samples are comparable with others taken at different areas at approximately the same time on the same date or with those taken in the same area on different days. However, the results are but an index to and not a definite measure of flight density, for flight was observed to be heavier in the mid-crown portions of trees. In addition, results of the sampling methods were found to be erratic in those areas in which light adult populations resulted from light infestations by the 1933 brood.

First flight was observed on July 11. Flight activity increased steadily until July 25, the date on which the first sample was taken. A peak in flight activity occurred about the last of July, or approximately 10 days after the peak of emergence. Appreciable flight continued at Porcupine Flat until August 12 (figure 2A). Observations after August 16 showed slight activity, the last moth in flight being observed on August 29.

Contrary to established opinion, flight in the infested stands during the auroral and vesperal periods of the day was much greater than

during the diurnal portion. Each day at about 7:00 a.m. and 7:00 p.m. flight reached its peak. Numbers of moths fluttered up and down or from needle to needle just outside of the crown limits on the lee side of trees and above 15 feet from the ground. Sometimes individuals went from tree to tree. During the day some flight occurred, although it was marked mostly as an effort at hiding, following foliage disturbance. However, the only movement that might be called migration, was observed during the middle of the day when a few individuals were seen floating on the mid-day updraft that usually occurs in creekbottoms and canyons.

## MIGRATION OF ADULTS

Although some flight that might be termed a migration was observed under the conditions described above, in no case has an observation been made involving mass movement. However, quantitative data secured in the Porcupine infestation unit and observations at Snow Creek and Lake Tenaya give definite indications of migration, both as to amount and time.

At Snow Creek and Lake Tenaya a sudden increase in the number of adults in flight occurred around August 7. This increase can only be attributed to the influx of moths from more heavily infested areas.

Samples were taken in the Porcupine infestation unit at seven points which are shown on the accompanying map. The 1933 infestation at these points, the distance from the center of infestation below the Porcupine Creek Campground, and the distance from the main channel of Porcupine Creek varied as follows:

| Sample point | 1933 Infestation | Distance from center of infestation. Numbers indicate the order of distance. | Distance from main Creek (Distance from migration route) |
|---|---|---|---|
| A | Heavy | 1 | Along creek |
| B | Heavy | 1 | Along Creek |
| C | Light | 2 | On ridge 200 yds. from creek |
| D | Moderate | 3 | Along creek tributary |
| E | Moderate | 3 | 100 yds from creek along / |
| F | Light | 4 | Near ridge 50 yds from creek |
| G | Very light | 5 | Along creek |

All observations made this year on 1933 infestations and data on the 1933 flight secured from the sampling areas (figure 2) point to the fact that migration is along creek bottoms, tributaries and canyons - in this case upstream. On ridge tops and open exposed slopes where conditions are more extreme, infestation and flight is lighter.

Environmental factors at the several sampling areas do not vary enough to result in any great variation in the timing of needleminer activities. However, three points of difference in the collection records from the sampling areas substantiate the conclusion concerning migration. The first of these is that the number of insect caught in the samples vary

according to the intensity of the 1933 infestation. This finding is to be expected. The number also varies according to the distance from the center of heavy infestation and along the creek bottom. This finding indicates the infestation is spreading. The third and important point of difference is that the peak of flight occurs noticeably later the greater the distance from the heavier infestation below Porcupine Flat, or the greater the distance from the main line of migration along the creek. The Peak of flight at each point should have occurred at approximately the same time as at Porcupine Flat.

The observation that infestations are heavier in the creek bottoms or on the better sites does not agree with previous observations. However, this variance may be explained by the fact that we are now observing an infestation in the process of expansion and establishment. Previous observations were all made in areas in which the infestation was well established.

## THE EGG STAGE

Attempts were made to secure a supply of eggs which it was hoped could be used in experimental work. All attempts were unsuccessful. Three eggs were seen in one of the cages but no records as to the length of the egg stage were secured. However, the period of time elapsing between the peak of emergence and the appearance of larvae in the field indicates a much longer period is spent in the egg stage than has been shown by previous records.

## INFESTATION BY THE NEW BROOD

Counts of needles were made at short intervals of time from August 6 until the completion of the field work on October 2. This was done in order to determine the start and progress of the 1935 infestation. Some continuation of this record was made possible by examination of material brought in from the field to serve as checks on control experiments. The basis for our data includes count and examination of over 150,000 individual needles.

No 1935 infestation was found in any area examined until September 9, when new mines were found at Porcupine Flat. The progress of infestation is shown in Figure 3A for (1) needles of current growth, (2) all needles, and (3) needles of growth previous to 1935. These curves show attack by the 1935 brood had not been completed by October 18.

Comparison of infestation conditions in 1935 with those of 1933 on given dates is made possible by samples totalling about 3000 needles that were examined in 1933. It is apparent that the infestation conditions were more advanced on the dates of examination in 1933 than on the same dates in 1935. This indicates that some variation exists in the appearance of the new brood in different years. However, the information shows hatching and infestation begins nearly a month later than had been determined previously.

Collections from different areas make possible a comparison of infestation intensity on given dates in those areas. This information is given in Figure 3B for the center of infestation south of Porcupine Flat, at Porcupine Flat and at Porcupine Creek in a relatively lightly infested area on September 16. In addition, comparison is possible between the infestations at Porcupine Flat, Lake Tenaya and Tuolumne Meadows on September 18 and 27.

Substantiation of the fact that needles of current growth are not selected for attack as often as those produced in previous years was secured during 1935. Figure 3A shows the extent of this selection. It was noted that, on those trees in which most of the older needles had been killed by previous heavy infestation, attack on current growth was much heavier than on trees having considerable foliage produced in other years.

It is apparent normal infestation is heavier in the older needles. The depletion of the supply of those needles in the long established infestations studied from 1917 to 1919 would account for the observation that attacks by the smaller larval stages occur chiefly on needles of current growth.

It also has been observed that initial attack may be on any portion of an individual needle, but usually occurs on the rounded surface about 1/4 to 1/2 inch from the tip. The mine may be extended in any direction from the point of entrance, but usually first activity extends it towards the tip of the needle.

All gradations of infestation intensity are to be found in different areas. No infestation can be found in some stands and very light, light, moderate or heavy infestations exist in others. Variation in the infestation on individual branches of single trees is also great. It appears that amount of oviposition and subsequent infestation in moderate to heavy infestations depends on the location of moths on the individual branches at the time of oviposition.

## PARASITISM OF LARVAE IN LODGEPOLE PINE NEEDLES

Ten apparently different species of parasitic Hymenoptera have been reared from lodgepole pine needles infested by the large larvae of the 1935 brood. An additional species has been secured from Jeffrey pine. It is not known if these species are primary or secondary parasites. All parasitic larvae that have been seen were external parasites.

Partial identification of three species can be made by comparison with specimens in the station collection. However, it cannot be certain that the material used for comparison is properly identified. Accordingly field designations have been utilized throughout the season and descriptions for field use have been made to allow separation in the absence of satisfactory pinned and identified material.

Field designation A - Eulophus sp?

1.5 to 2.5 mm long. Antennae black. Head, thorax and abdomen blue-green. Front, abdomen and ventral surface of thorax sometimes more nearly black. Head and thorax densely punctate, abdomen nearly smooth. Legs, except foreleg, black with tips of coxae, trochanters, tips of femora, tibiae and at least the two basal segments of the tarsi whitish or cream colored. Foreleg more nearly entirely black. Wings somewhat iridescent. Marginal, submarginal, stigmal and postmarginal veins present.

Field designation B -_____

This field designation has been found to contain three species of Ichneumonidae. They have been redesignated as B, B1, and B2 and have the following general appearance.

Field designation B - _____

1 female 5 mm long plus 4 mm exserted ovipositor. 1 male. Filamentous antennae, head, thorax and abdomen black. Ovipositor of female exserted, black. Head nearly smooth, thorax finely punctate, pubescence short and silvery. Propodeum more distinctly punctate; pubescence silvery and longer. Abdomen densely punctate. Wings slightly iridescent; stigma large, triangular; areolet 4-sided. Foreleg honey yellow, coxae and trochanters almost entirely white in male. Middle and hind legs honey yellow, tibiae and tarsal segments darker with white strip on posterior surface of tibiae and whitish basal annulations on tarsal segments.

Field designation B1 - _____

1 specimen 4 mm long. Antennae somewhat clavate, black above, brownish beneath and towards base. Head, thorax, propodeum and abdomen black, moderately punctate, the basal segments of the abdomen more clearly punctate than those following. Pubescence short, silvery. Wings slightly iridescent, stigma triangular. Areolet 4-sided. Legs black with tarsi, tips of trochanters and extreme basal portions of femora more or less brownish.

Field designation B2 - _____

8 males, 5 mm long. Filamentous antennae black, scape and pedicel lighter beneath. Head, thorax and abdomen black. Clypeus and mouthparts light yellow. Head and thorax lighly punctate, abdomen more densely punctate. Propodeum punctate and with definite but not strongly marked longitudinal ridges. Legs black, foreleg and middle pair lighter with brownish marks on all except the tarsal segments. Wings somewhat iridescent. Areolet 5-sided.

One specimens agrees in general with the above description but has a yellowish spot on the orbits and the legs are almost entirely honey brown.

Field designation C - Zecalochlora milleri Cwfd.?

Several specimens, apparently of both sexes. Small, about 1.5 mm long. Head, thorax and propodeum brilliant metallic green, densely punctate. Abdomen smooth and metallic green except for broad band on apical portion of first segment which is yellow. Antennae with all except terminal segment yellow, terminal segment black. Coxae metallic green, all other segments of legs yellow except tips of tibiae and last segment of the tarsi. Wings with marginal, submarginal, stigmal and postmarginal veins present and yellowish in color.

NOTE: This species, according to notes on specimens in the station collection, may have been reared from several other hosts. However, the inclusion of several obviously different species under this specific name in the collection makes it difficult to identify which form is this species without reference to the original description and considerable study.

Field designation E - _____

2 males, 16 females, 3 mm long.

Males: Almost entirely black except tips of tibiae and tarsal segments. Hind femora slightly enlarged, not toothed beneath. Abdomen scarcely petiolate.

Females: Antennae, head, thorax and abdomen generally black with spots of variable extent of yellow and brown as follows: on mandibles, maxillae, malar space, clypeus, orbits, vertex, antennae, pronotum, mesoscutum and scutellum, abdomen and legs. Head, thorax, and propodeum densely punctate, silvery pubescent. Abdomen with petiole punctate, remaining segments smooth. Posterior coxae elongate, conical. Posterior femora much enlarged with a row of teeth along anterior margin. Wings slightly iridescent with submarginal, marginal, stigmal and postmarginal veins distinct, other venations present but indistinct.

Field designation R - _____

12 specimens. 1.5 to 2 mm long. Antennae, head, thorax and abdomen black with some metallic green luster. Head and thorax clearly punctate, abdomen nearly smooth. Antennae and legs wholly or in part sometimes lighter and fuscous. Wings with marginal, submarginal, stigmal and postmarginal veins present.

Field designation Y - _____

6 specimens. 2.5 mm long. Antennae, head, thorax, abdomen and legs almost entirely yellow with dark markings. Basal and apical segments of antennae light fuscous. Eyes red. Head and thorax marked by fine black lines giving the effect of reticulations. Abdomen above with black transverse lines and a single fairly broad longitudinal line down the middle. Wings iridescent with submarginal, marginal and stigmal veins present. Transverse fuscous clouds appear near apex, at stigmal vein and at end of submarginal vein.

Field designation X - _____

Many specimens of both sexes. Length 2 mm. Ovipositor of females exserted 1.5 mm. Filamentous antennae, head, thorax and abdomen black, moderately punctate. Legs honey brown, or darker, marked with fuscous particularly on femora, tips of tibiae and tarsal segments of hind pair. Wings unmarked by clouds, scarcely iridescent. Stigma large, triangular, veination Braconid type.

Field designation Z - _____

Many specimens of both sexes. Length from 2 to 2.5 mm. Head and body cuprous iridescent, head and thorax strongly punctate, abdomen smooth. Antennae and legs somewhat lighter ranging to brownish. Wings unmarked, iridescent. Submarginal, marginal, stigmal and postmarginal veins present.

The timing of emergence of the different species found in lodgepole pine in relation to each other as well as in relation to the host emergence is of interest. This information is given in Figure 4. In addition, in Figure 4A, the relative abundance of emergence from a measured amount of host material (5000 infested needles) is given. The record showing timing of emergence was terminated on September 18. However, the material was retained and the total emergence determined up to November 12. Seperation of the intensive and extensive records is made in Figure 4A.

PARASITISM OF LARVAE IN JEFFREY PINE NEEDLES

Parasites emerging from Jeffrey pine needles collected by Mr. S. T. Carlson at Merced Lake contained the following species of parasites:

A-- 4 specimens
B-- 1 female specimen
B1- 4 specimens
B2- 2 specimens
C-- many specimens
Y-- 6 specimens
X-- 8 specimens
H-- many specimens; of a species not found in the rearings at Porcupine Flat this season although it was collected by Patterson from larvae in lodgepole pine. Description of this species is as follows:

Field designation H - Encyrtid near Copidosoma

1.5 mm long. Antennae brownish black, somewhat setaceous in female, more nearly moniliform and pubescent in males. Head and body somewhat metallic in color, pronotum definitely so. Remainder of body more nearly black. Head and thorax rather evenly punctate, abdomen smooth. Coxae and femora, except at tips, black. Tibiae in hind legs and sometimes in other pairs darker at base. Tips of femora, most of tibiae and all except tips of last tarsal segments whitish or cream colored. Wings slightly iridescent. Marginal, submarginal and stigmal veins present.

There is a possibility that the host species is not Neoclysia milleri.

FIG. 1

# LODGEPOLE NEEDLEMINER EMERGENCE

## PORCUPINE FLAT, YOSEMITE NATIONAL PARK

BASIS : 5,000 NEEDLES

*EMERGENCE EXPRESSED IN PERCENT PER DAY*

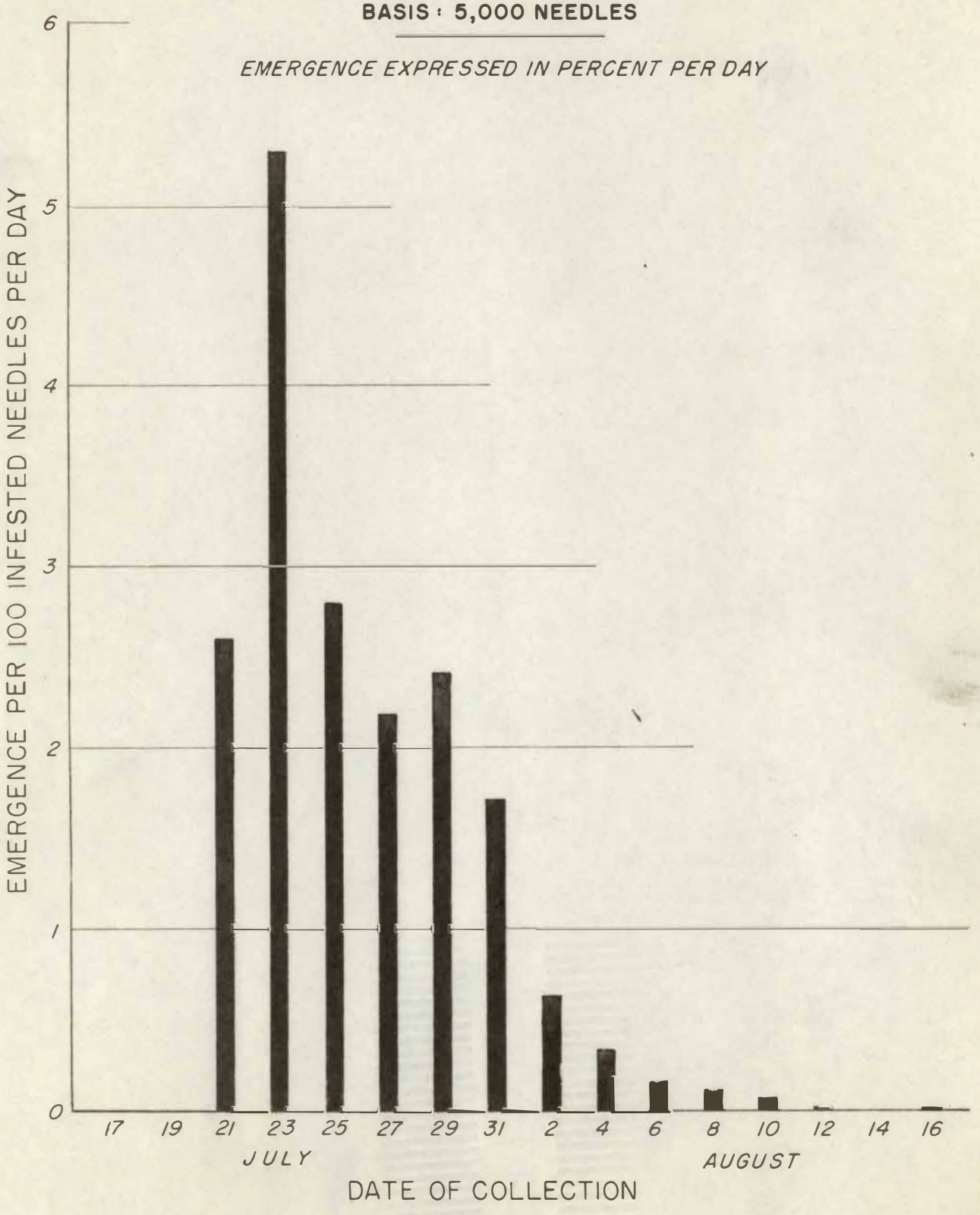


FIG. 2

## SAMPLES DETERMINING FLIGHT AND SPREAD OF MOTHS TO THE NORTHWEST PORCUPINE CREEK INFESTATION AREA – YOSEMITE NATIONAL PARK

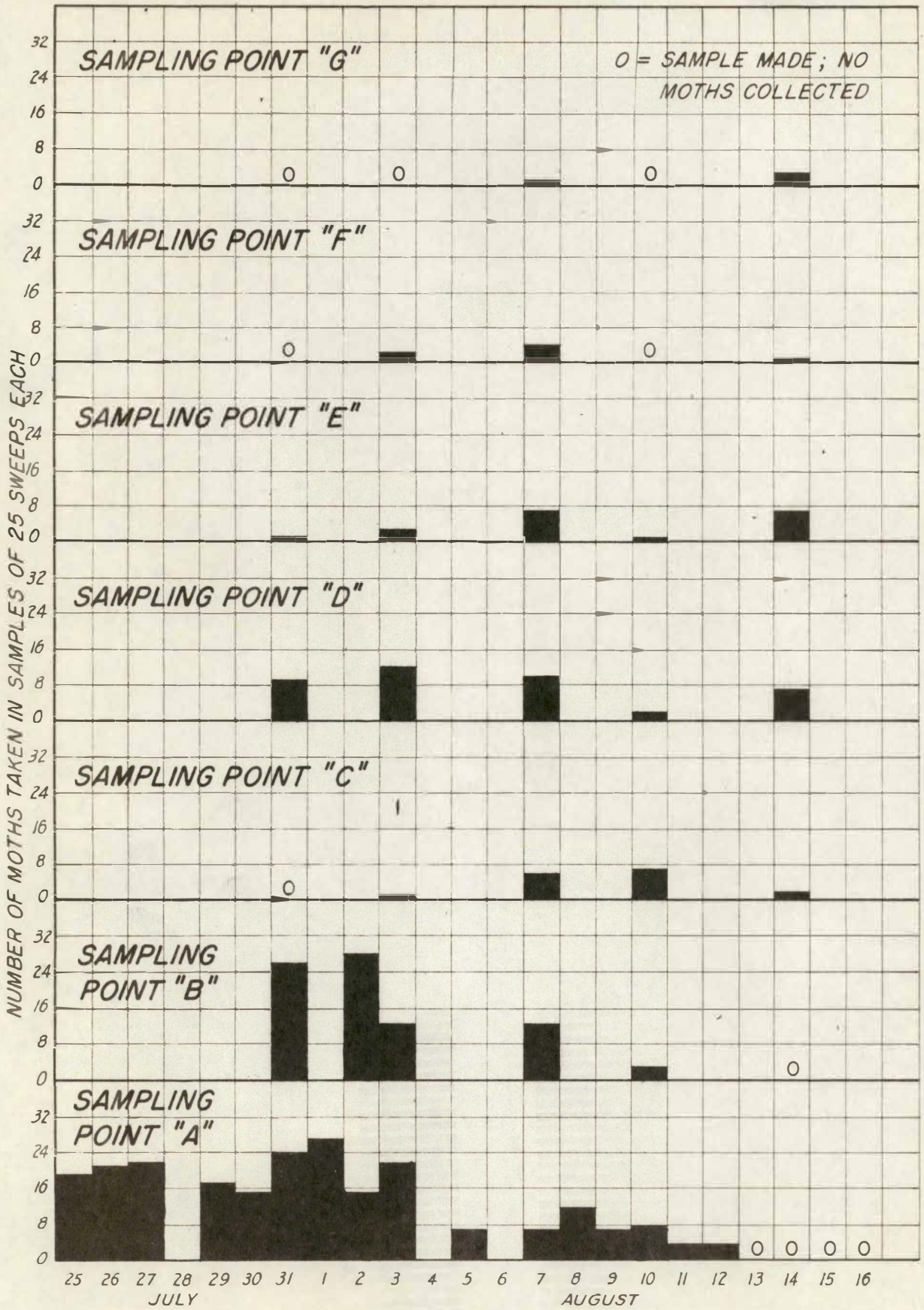


FIG. 3A

## DEVELOPMENT OF 1935 INFESTATION

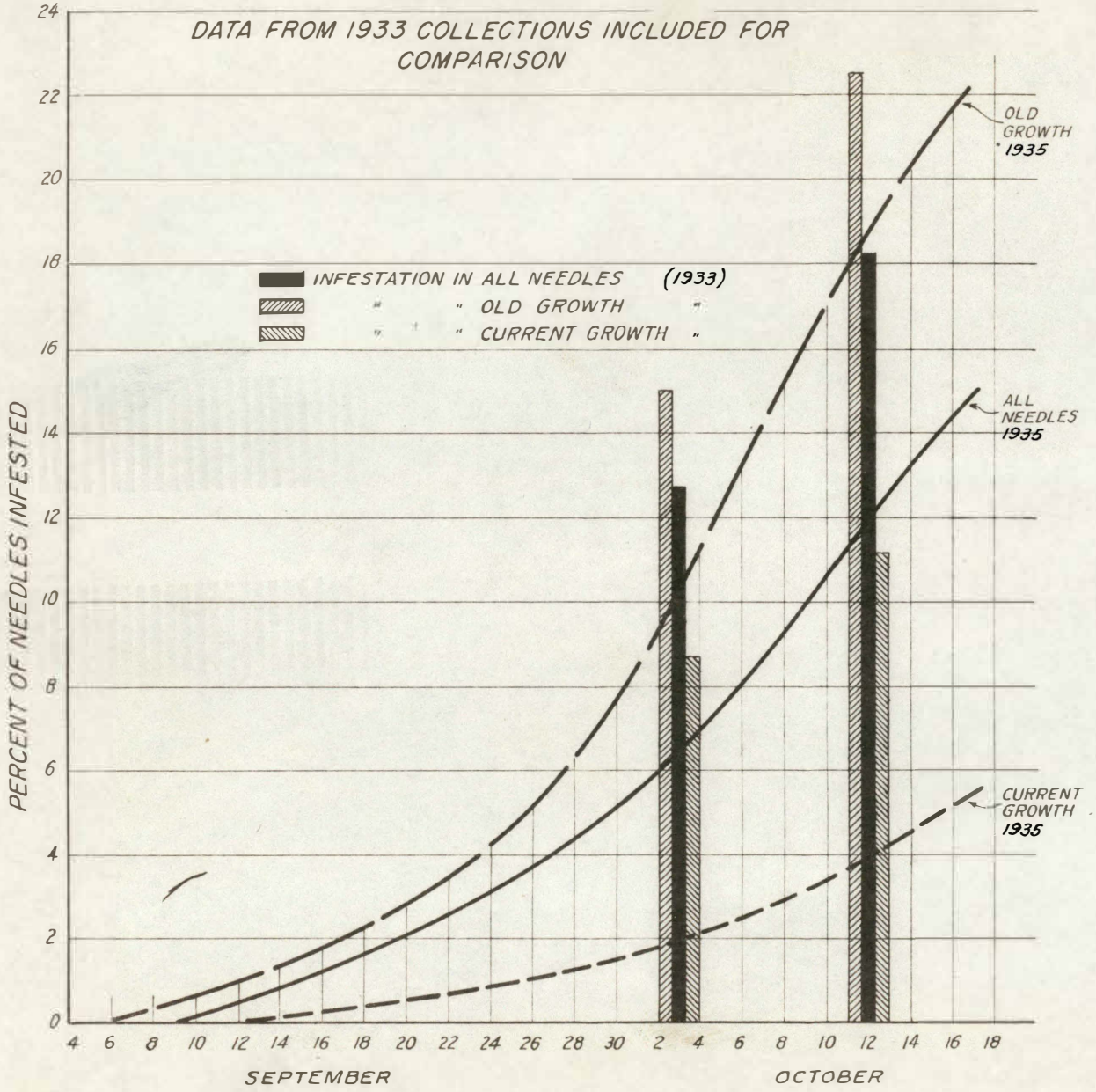



FIG 3B

## COMPARISON OF 1935 INFESTATION IN DIFFERENT AREAS

FIG. 4

## EMERGENCE OF PARASITIC SPECIES

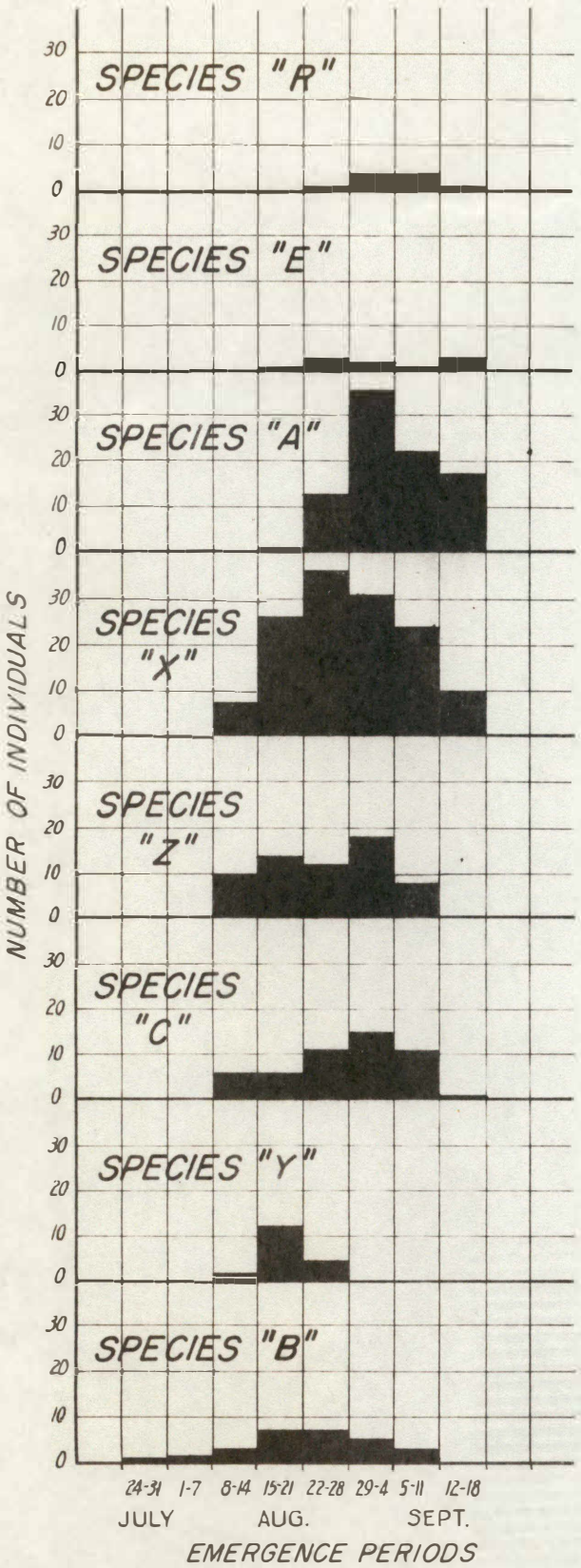
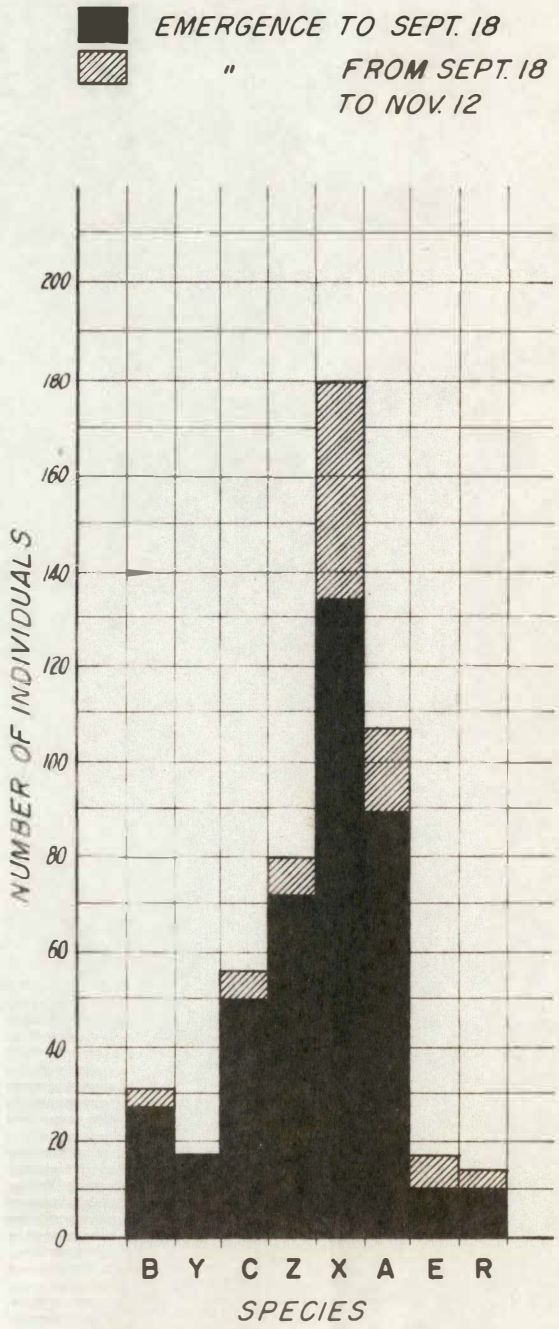
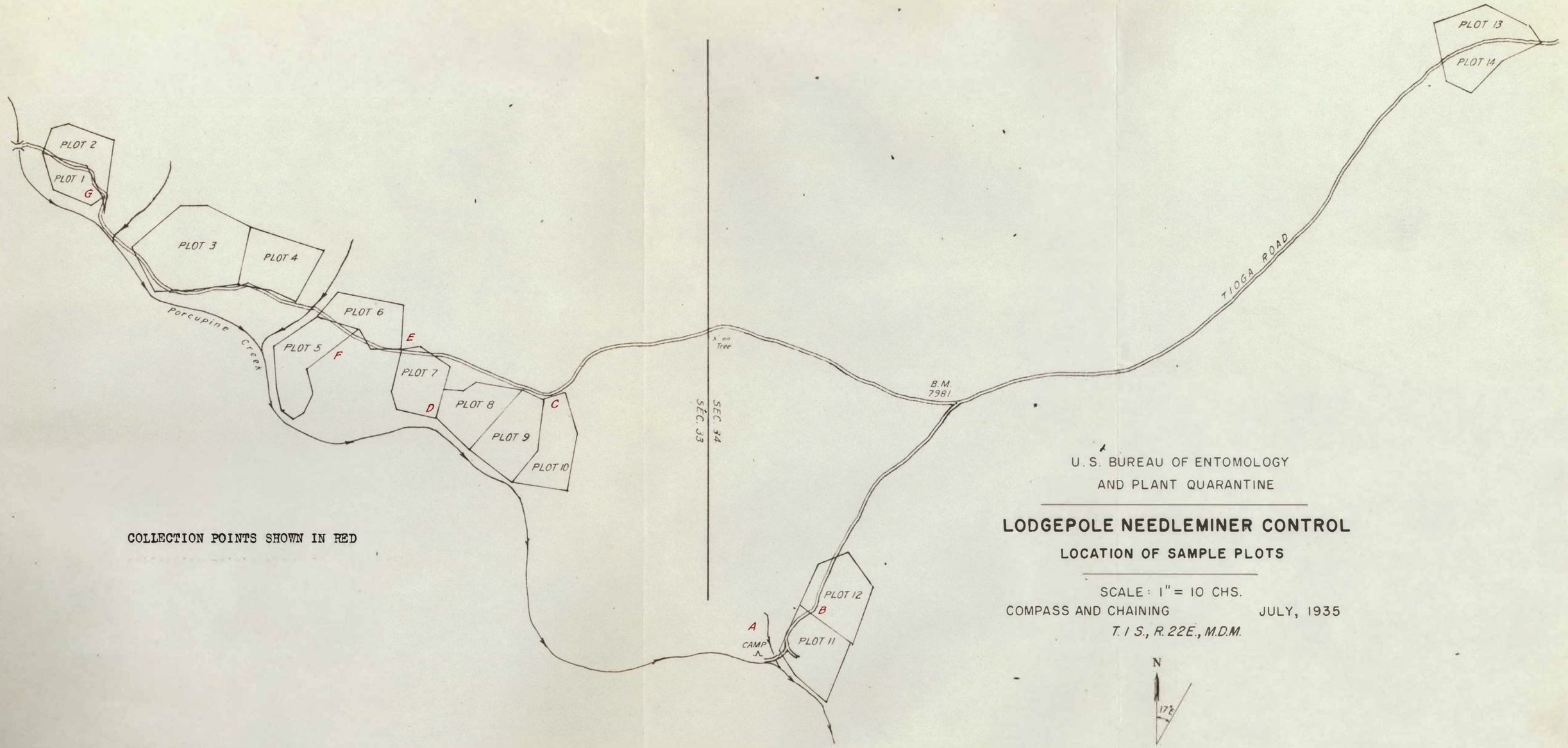



FIG. 4A

## NUMERICAL IMPORTANCE OF PARASITIC SPECIES






COLLECTION POINTS SHOWN IN RED

U. S. BUREAU OF ENTOMOLOGY
AND PLANT QUARANTINE

# LODGEPOLE NEEDLEMINER CONTROL

## LOCATION OF SAMPLE PLOTS

SCALE: 1" = 10 CHS.

COMPASS AND CHAINING JULY, 1935

*T. 1 S., R. 22E., M.D.M.*